M-1

Transport Canada / Transports Canada

Development / Développement

TP 3936

Canadian Overview of Technological and Systems Research and Development on Transportation for the Disabled

Prepared by the

Transportation
Development Centre

Montreal, Quebec

for the

Transportation
Research Board
62nd Annual Meeting
January 17-21, 1983

Washington, D.C.

CA1
DTC 800
32
C15
c.2

Canada

36v

TP 3936

Canadian Overview of Technological and Systems Research and Development on Transportation for the Disabled

by

Ruth M. Heron
Barbara A. Smith
Ling Suen
F.A. Alfieri

Transportation Development Centre
Transport Canada
Montreal, Quebec

Transport Canada Central Library (GSLA)
CU LE
APR 29 1983
Transport Canada | Transports Canada

for

Transportation Research Board
62nd Annual Meeting
January 17-21, 1983
Washington, D.C.

Acknowledgements

The authors gratefully acknowledge the kind assistance of Roy Nishizaki and Wayne Rowan in the preparation of this paper.

Abstract

This paper provides a general view of existing and planned innovations in technology and systems in Canada relating to transportation of citizens with motor, hearing, sight, speech, or cognitive impairment. Treatment of urban transportation in the paper highlights various advances in technology relevant to parallel modes. For example, the award-winning design of a wheelchair securement/passenger restraint system is described. Developments related to interurban systems are shown to be comprehensive, covering, as they do, problems experienced by special needs travellers within air, rail, and surface modes, both at terminals and in transit. Canada's less extensive applications in rural settings are also discussed.

Introduction

Among the many recommendations made in 1981 by a Special Parliamentary Committee on the Disabled (1), those relating to transportation were seen by many as key factors in guaranteeing Canada's one million disabled citizens their right to independence and life satisfaction. However perhaps few would comprehend the enormous difficulties involved in conceptualizing, designing, developing, testing and implementing the technological and systems innovations required to bring our objectives for the transportation disadvantaged to fruition. Of course numerous relevant projects had been undertaken prior to 1981, with Transport Canada's Transportation Development Centre (TDC) spearheading the effort. Still, the Special Committee's announcements have alerted various government and other bodies concerned with transportation research and development to the need for greater activity in areas affecting the disabled. Hence funds for these purposes have been freed up to some extent, and the move toward new and creative technological and systems approaches to problems of the transportation disadvantaged has gained in momentum and co-ordination.

This paper attempts to provide an overview of the state of the art in Canada in this respect by giving an account of what has already been accomplished and of what is now in progress or is planned. An overall schema of urban, interurban, and rural transportation systems is adopted for the presentation, the various types of subsystems and relevant technological developments then being discussed within these three major contexts.

Urban Systems

Fixed Route Transit. Only one Canadian city, Victoria in British Columbia, has attempted adaptation of fixed route public transit for use by wheelchair occupants. In the spring of 1979, British Columbia Transit, working with the Capital Regional District, installed wheelchair lifts in four transit buses operating on a fixed route servicing an area dominated by elderly people (2). Manufactured by Transi-Lift Equipment in Calgary, the lift included several features providing safety against operator error. However field evaluations of system effectiveness, conducted over a period of eighteen months, were disappointing: equipment breakdowns were frequent after start-up, but more importantly and quite apart from this fact, initially heavy use of the system eventually declined to zero because of the

difficulty wheelchair users had in reaching bus stops. As a consequence, Victoria removed the lifts from the vehicles and shifted its effort to paratransit modes. This negative experience was scarcely an encouragement to other Canadian cities considering integrative transport for the disabled.

Modifications that would render public transport accessible to the cognitively impaired, the ambulatory elderly, and certain other special need groups are somewhat less formidable than are those necessary to accommodate wheelchair passengers. In the case of cognitively or speech impaired individuals, for example, the barrier is largely one of communication and, thus, can be overcome with some simple technical aid. Co-operating with the National Research Council, TDC is addressing this area in a project dealing with the design and evaluation of remedial technology.

Apropos of the elderly, it is well known that declining strength impedes efforts of these citizens to mount the high first step on public transit vehicles, to get in and out of seats, to stand when no seat is available, or to ambulate when the vehicle is in motion. In major Canadian cities such as Montreal (3), Toronto (4), Calgary (5), Edmonton (6) and Vancouver (7), installation of entrance grab bars and extra stanchions on certain seats has brought about some alleviation of these conditions. However lowering the first step to the point of easy access by the elderly is associated with engineering difficulties not only because the suspension is not readily accommodated under the vehicle's floor, but also because heavy snowfalls so common in Canadian winters interfere with clearance. Toronto has recently obtained ten Flyer Industries air-conditioned buses with the kneeling feature whereby the driver can activate an electronic mechanism that releases air from the bellows and, hence, causes the front end of the bus to lower itself by 15 to 20 cm (8). It is intended that these buses will be operating as a regular suburban service, except in the summer when they will be leased to Grey Coach Lines for tours. Toronto's evaluation will determine whether the kneeling feature will be workable in Canada. Meanwhile TDC is undertaking a comprehensive and detailed analysis of elderly citizens' problems with public transit in order that a meaningful and holistic approach to remedially-oriented systems and technological research and development can be mapped out.

Parallel services. As is true in the U.S.A., most cities in Canada have some sort of door-to-door transit service in operation (9). In small centres where demand is low, the service is likely to be provided through private

donations from benevolent organizations. In major cities, though, the trend is for responsibility to be taken by the relevant transit authority, which then either provides the service itself or contracts it out. Most systems require one-day advance reservation and do not have the capability of handling on-demand scheduling. Only too familiar are the dispatch snags and snarls that occur as these many-to-many systems attempt to cope with peak loads and cancellations. Auguring well for improvement in this repect is the success of a computerized dispatcher/driver communication system, developed by Canada Systems Group and recently installed by Blue Line Taxi in Ottawa (10). On receiving keyed-in telephone taxi orders, the computer in this system allocates the order to a given district, relays the message to taxis in the area, and displays a one-line message to the driver. The message displays, as well as a small key pad used by the driver for responses, are interfaced through a digital adapter with the standard taxi radio; thus, voice communication can be used in emergencies. Also, TDC is now sponsoring a study by the Centre de recherche sur les transports, Université de Montréal, to construct a scheduling and routing algorithm to facilitate dispatching of transit vehicles for the disabled.

Technological developments with respect to the vehicles used in these door-to-door systems usually refer to the modification of minibuses or standard vans such as the Ford Econoline or Dodge Maxivan (11). Many companies in Canada undertake such modifications and, indeed, TDC itself explored the relevant technology in an early project (12). The Datsun 710 subcompact station wagon involved in this project underwent numerous adjustments, the principal among them being the lowering of the floor, the raising of the roof, and the provision of an aluminum non-slip ramp. The adapted vehicle appears in Figure 1. Its evaluation by the Quebec ministry of transport showed manoeuverability to be excellent, occupancy per trip to be high, and fuel consumption to be low.

However, it is of course a truism that none of these modified vans is fully satisfactory in terms of operability, comfort and safety. As a reaction to this reality, TDC has recently initiated a project in co-ordination with the Canadian Urban Transit Association (CUTA) to fund the development of a specification and tender document for a prototype vehicle designed especially for the urban transportation of disabled persons (13). Critical to the concept of the prototype are the requirements that it be a heavy duty bus with transit-type reliability, have a low floor and kneeling suspension for easy access, be able to accommodate four wheelchair and five seated passengers, be

Figure 1 Datsun 710 subcompact station wagon modified by TDC for use by wheelchair passengers.

Figure 2 The GSM taxi, which can carry one wheelchair passenger along with three ambulatory passengers

ergonomically suitable for such passengers in all respects, and be equipped with crash-tested wheelchair securement/passenger restraint systems.

Although expensive, the taxi does offer the disabled individual a one-to-one service, which is often desirable and sometimes necessary. Yet getting the disabled person and the wheelchair in and out of the cab is burdensome for both driver and passenger. A vehicle that offers a solution is Canada's GSM taxi, shown in Figure 2. Designed and built by Guillon, Smith, Marquart & Associates Ltd. with the support of TDC (14), this vehicle can adjust to accommodate either five ambulatory passengers or three ambulatory and one wheelchair passenger and, because of wide doors and a portable ramp, is readily accessible to wheelchairs. Additionally, having the same type of suspension, power-train, and electrical parts as other automobiles built in North America, the vehicle is suitable for Canadian weather conditions.

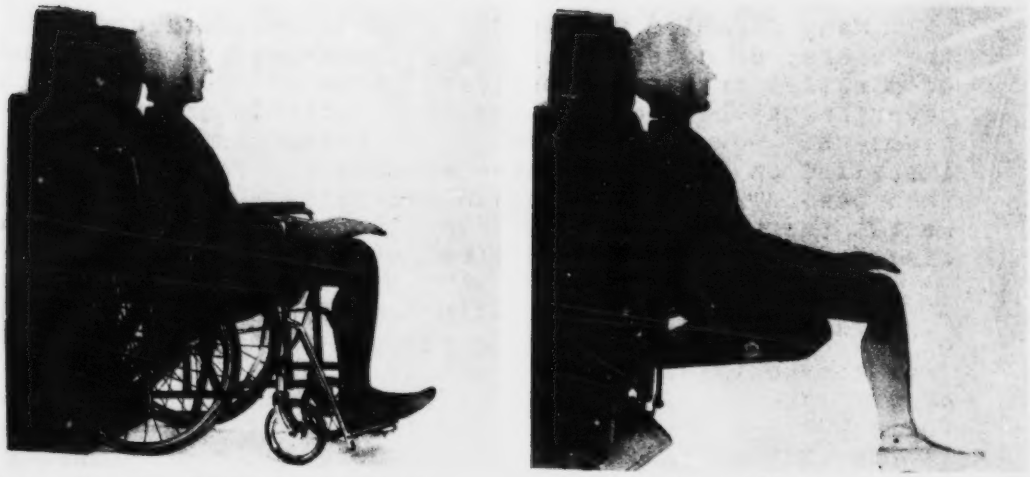
Paratransit vehicles are associated with two accessories, namely, lifts (or ramps) and securement devices, which are of particular technical concern. In Canada, lift manufacturers must try to find materials and develop mechanisms that guarantee operability during the cold and snowy conditions of our winters. One lift, made by Services Industriels Savaria Enregistrée in Quebec (15), operates by sliding across the van floor and then descending to ground level. When the wheelchair occupant backs onto the platform, a safety stop rises automatically, thus preventing forward motion. After the user is rolled into the van, a switch-operated mechanism automatically stows the lift in the van. Although collected snow then has a chance to melt away, and although this lift has other desirable features, its pronounced disadvantage is that it occupies space in the van that could be used by an additional wheelchair passenger. One of our most satisfactory lifts is that manufatured by Para Industries (1978) Ltd. of Ontario (15). The two models of this lift, the Mark II and Mark III, are adapted, respectively, for installation in vans with and without steps. Both are of the electro-hydraulic platform type, and both have folding handrails, fixed side wheel stops, and an automatic safety flap that also acts as a boarding ramp. The platform is stowed vertically just inside the door of the van.

Of the many types of securement devices in use in Canada, one represents a unique technological accomplishment in the field of passenger safety. Designed by Uwe Rutenberg of Les Designers Douglas Ball Inc. of Ste Anne de Bellevue, Quebec, and developed by TDC, this multimodal wheelchair

securement/passenger restraint system (16) received a Design Canada award in 1982. The unit consists of four modules, namely, a wedge-shaped base, a lower back structure, an upper back structure with adjustable headrest, and an optional seat. The wheelchair is backed into place and secured with restraining arms that pull out telescopically from the base and fasten over the wheel rims. A lap and shoulder belt serve to restrain the passenger. Illustrations of wheelchair and ambulatory use of the unit are presented in Figures 3a and 3b respectively. This system emerged from a 47 km/h barrier crash test without structural damage to either unit or chair and without disturbance of the position of the anthropometric dummy. These results definitely confirm that the system meets its designer's aim of providing the wheelchair passenger the same level of safety enjoyed by any other passenger riding in a vehicle.

TDC's involvement in the development of the kinds of vehicles and equipment described above has enabled it to play a strong role in creating awareness of the need for relevant standards, and to become a useful representative on the Canadian Standards Association's Committee on Motor Vehicles for Transportation of Physically Disabled Persons. Now in the process of writing standards for relevant vehicles, this committee is addressing issues of crash protection, interior head room, dimensions of ramps (or lifts) and doors, type of lighting, and control of temperature and air quality. Additionally, TDC is collaborating with the Roads and Transportation Association of Canada on the contracted preparation of a handbook of guidelines for taxi and paratransit vehicle technology, operation and regulation. In Ontario, legislation is now enforcing regulations respecting specifications for ramps, lift platforms, securement devices and other features of paratransit vehicles, which have been set by the Program Development Branch, Transportation Regulation Division, of the province's Ministry of Transportation and Communications (17).

Personal transport. An estimated 5.6 per cent of disabled people in Canada depend on the conventional wheelchair for mobility. Barriers commonly faced by these wheelchair users are curbs, steep slopes and rough terrain. To surmount these barriers a curb-climbing electric wheelchair was developed for TDC by Les Designers Douglas Ball Inc. The chair features unique twin rear axle design, which provides curb-climbing ability and improved traction and stability (18).



(a) for the wheelchair passenger (b) for the ambulatory passenger

Figure 3 TDC modular multimodal wheelchair securement/passenger restraint system (Designed by U. Rutenberg)

Figure 4 The curb-climbing electric wheelchair

Many disabled people drive their own cars and, therefore, do not need to avail themselves of either public or parallel transport services. Some of these drivers may nevertheless be aided by the hand controls appearing in Figure 5. Developed by TDC (19), these controls can be installed in less than three minutes and removed in less than one. This quick intallation/release feature makes car rental for urban transport a much greater possibility for disabled drivers than was previously the case.

Because of the physically demanding and awkward nature of the operations of stowing the chair and retrieving it from the vehicle, many wheelchair drivers would be well accommodated by a car such as the British Elswick Special Vehicle (20), which allows the individual to enter the car in the wheelchair and to remain there while driving. The possibility is being entertained of bringing this vehicle into Canada, but the final outcome will rest on whether it complies with standards and regulations for all new vehicles in Canada, as set by the Road and Motor Vehicle Traffic Safety Branch of Transport Canada. In any case, some thought, albeit embryonic, is being given to the possibility of developing such a vehicle in Canada. Also only in the germinal stage is consideration of development of a car specially designed for elderly drivers. Easy entry and exit, good seating comfort, high manoeuverability, easy operability, and expanded scanning capacity would be desirable features of such a vehicle.

Interurban Systems

Terminals. Intercity travel is often denied or made onerous for certain members of society because of various obstacles encountered at rail, air and ferry terminals. To cover this aspect of technology and systems in its program on transportation for the disabled, TDC has initiated a number of projects. For example, now under examination is the possibility of development of communication technology that would have applications for the speech, sight and hearing impaired in terminals and in vehicles during transit. Heretofore the only step toward accommodating this type of need in Canada has been the provision of safety information in braille aboard Nordair aircraft (21). Another TDC project calls in part for preparation of terminal design guidelines to facilitate the handling of speech, sight and hearing impaired travellers, as well as those in wheelchairs and others with ambulatory difficulties (22). This work plan includes development of a conceptual design for a modular transfer vehicle for use by certain members of the special needs group in the various types of

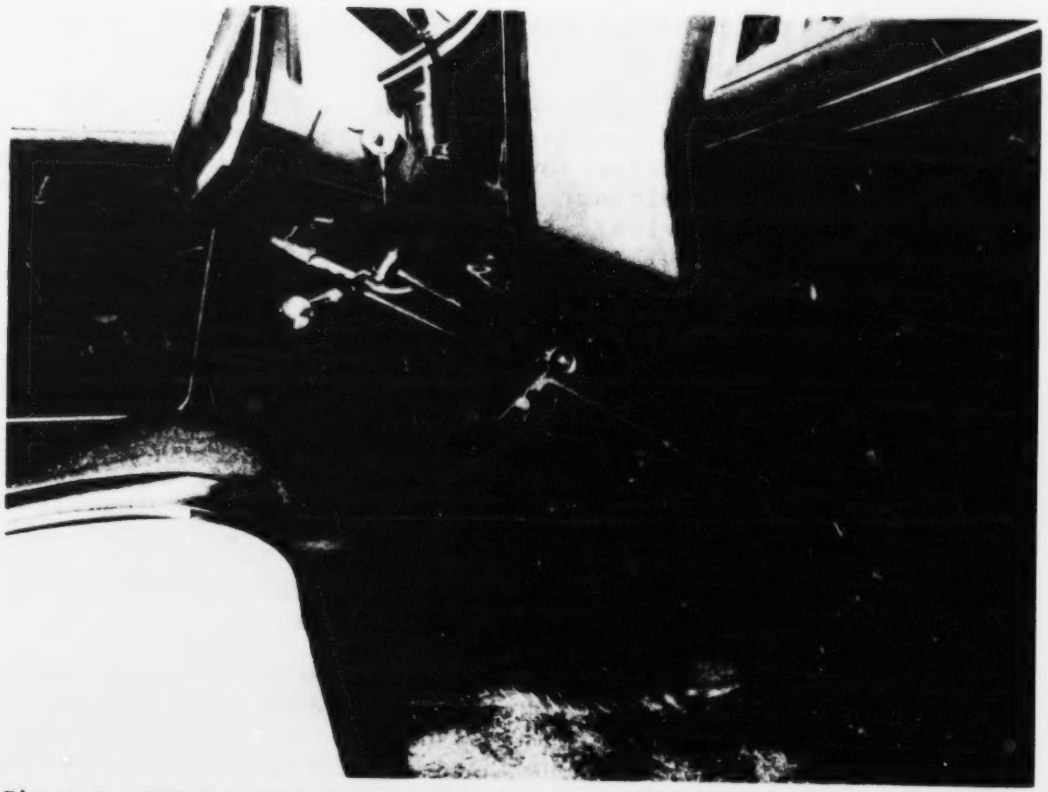


Figure 5 TDC quick-release car hand controls

(a) for the wheelchair traveller — (b) for the ambulatory traveller, with second platform for baggage

Figure 6 TDC modular transfer vehicle for use in terminals
(Designed by U. Rutenberg)

terminals (23). Preliminary versions of the vehicle appear in Figures 6a and 6b.

Two airports in Canada, those at Ottawa and Halifax, are equipped with inclined stairway-mounted wheelchair elevating devices that overcome problems of grade changes in transporting wheelchair travellers to the loading bridge. A pair of these devices is now being installed in the Kingston, Ontario, railway terminal where TDC, in co-operation with VIA Rail, is arranging for demonstration and evaluation; results of these tests will permit recommendations to be made with respect to possible use in other terminals. Apart from this effort, VIA Rail has drawn up an extensive program for making its major stations accessible in every way to disabled travellers (24).

Air travel. That Canadian airlines are very much gearing up toward facilitating air travel for disabled individuals is manifest in the fact that all major companies, such as Air Canada, Nordair and CP Air, either have or are considering programs to train personnel to deal with such passengers (25). Air Canada appears to be particularly active in developing and implementing technological change (26). For example, this airline is now evaluating a number of passenger-loading chairs, the successful one of which will replace the awkward and uncomfortable Washington chair. As well as other features, the selected model will have leg and heel straps, which are so important in preventing discomfort or accident among those with loss of muscular control of the lower limbs. An innovative option is the on-board chair shown in Figure 7, which allows the passenger to be wheeled to the washroom. In addition, Air Canada has installed removable armrests on all DC9 aircraft in order to permit easy transfer from wheelchair to seat. Its new Boeing 767s, soon to arrive from the U.S.A., will have not only this feature but also special washroom facilities for the disabled.

Air travellers in wheelchairs are frequently concerned about the condition of their chairs on arrival at destination and, if the chair is electric, about getting the wet-cell batteries transported. These matters have been approached by TDC and some of the airlines. For example, under a recent TDC project, a disposable corrugated cardboard container for wheelchairs was developed and tested by Hickling-Partners Inc. of Ottawa. However a reusable reinforced canvas container (see Figure 8), developed by Davis Engineering under TDC sponsorship, was found to be more suitable and is now being subjected to field tests by Air Canada and CP Air (27). A number of alternatives for dealing with wet-cell batteries were considered recently by

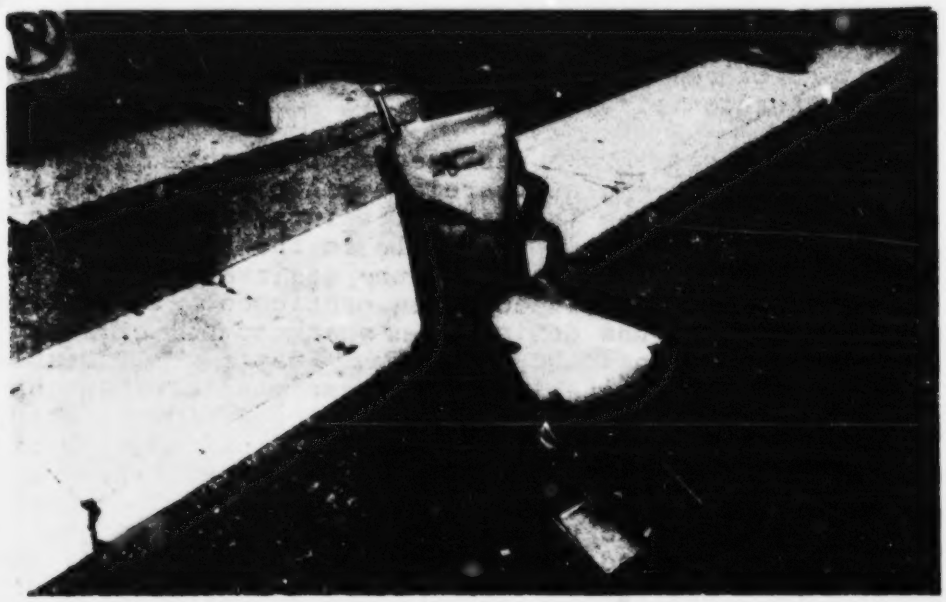


Figure 7 Air Canada on-board wheelchair

Figure 8 Reusable reinforced canvas wheelchair container

TDC. Air Canada, however, has developed the packaging kit appearing in Figure 9 and, as this kit has conditional Transport Canada approval, it is likely that it will be used by all Canadian airlines (28).

Rail travel. Much has been accomplished in Canada through TDC's co-operative relationship with VIA Rail, which at an early date had indicated its interest in making its services and facilities available to the transportation disadvantaged. The testing of the stairway-mounted wheelchair lift has already been mentioned. An earlier project involved the design of a coach to be included in the make-up of VIA's new LRC (for light, rapid, comfortable) train, and to be suitable in all respects for wheelchair passengers (29). This car now contains a widened entry space, an accessible washroom with well-placed grab bars, a wheelchair station, and a passenger chair with removable armrest for easy transfer from wheelchairs. The wheelchair station was designed to house a restraint system that was developed by TDC and is, in fact, the forerunner of the multimodal model (30). When installed against the bulkhead and fastened to the floor, the unit secures the wheelchair by means of telescoping arms that pull out at an angle of 45° to the floor. Ergonomic evaluation proved the system to be fully operable by paraplegics. Figure 10 gives a view of the VIA Rail installations.

Intercity bus travel. Recognizing that the intercity bus could represent an inexpensive and pleasurable means of travel for many Canadians in wheelchairs, the Special Parliamentary Committee on the Disabled recommended in 1981 that bus services under federal jurisdiction make their vehicles accessible to wheelchair passengers. Only one service is in fact under federal jurisdiction, the Newfoundland CN Roadcruiser service, which objected to the recommended action on cost/benefit grounds. For the subsequent inquiry held by the Canadian Transport Commission, TDC was tasked by Transport Canada to provide a design for an accessible Roadcruiser bus. The resulting TDC project included consideration of general, technical and safety requirements as well as those particularly related to lift and securement devices (31). Installation layouts and drawings clearly demonstrated the feasibility of modifications that would render the CN Roadcruiser fully accessible to those in wheelchairs. However, the Canadian Transport Commission's ruling was that the implementation of the Parliamentary Committee's recommendation for an accessible fixed-route bus was unwarranted at this time, for two reasons: the lack of accessible feeder services and the lack of flexibility of fixed-route services to meet the needs of the disabled (32). The Commission recommended the

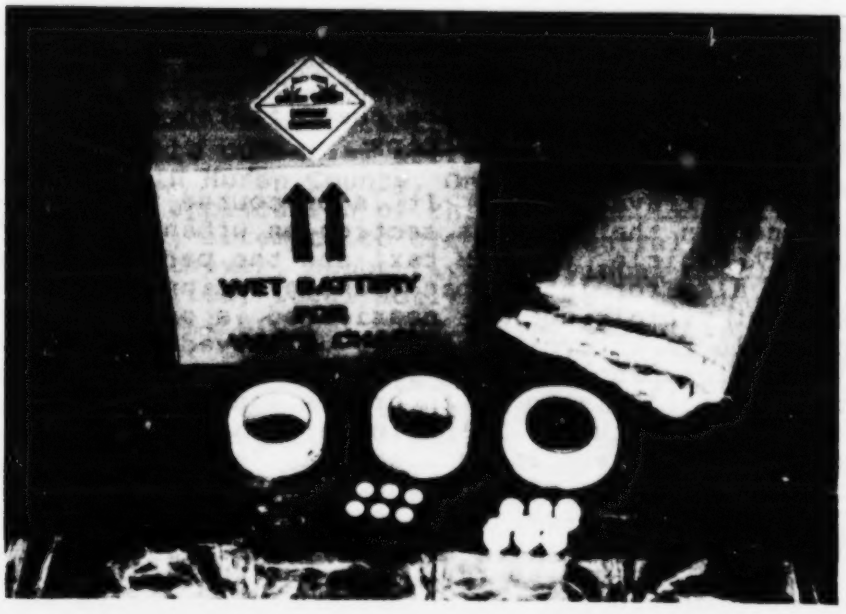


Figure 9 Air Canada wet-cell battery packaging kit

Figure 10 TDC rail wheelchair securement system and accessible washroom on VIA Rail's LRC train

use of smaller buses on a flexible schedule and route, phased in to correspond with market build-up. The Commission also recommended that, in the interim, wheelchair travellers be subsidized for the difference between bus and air fare on cross-island trips.

Other travel modes. It is of course true that vehicles mentioned in the previous section on urban systems - namely, the CUTA vehicle, the GSM taxi and the personal cars - can be used also for interurban transportation of the disabled. A type of vehicle not yet considered is one rather more applicable to intercity travel, conceived as it is as one suitable for people living in institutions and for whom outings are likely to be in groups and of long-haul, recreational nature. Trips in this case might consist of, for example, interurban educational jaunts, camping excursions, shrine visits, and so on. As these travellers may be severely disabled, with some perhaps on stretchers, a suitable vehicle would require special loading, suspension, housing and other features. Two such vehicles are the Van Hool articulated bus, which accommodates twelve stretchers along with seated passengers, and the Swedish Volvo mobile hospital vehicle. The aim of a current TDC project is to arrive at a full set of technological specifications for such a vehicle, suitable for Canadian use, after which, depending on the feasibility, prototype development may be undertaken.

Rural and Small City Systems

In Canada, questions regarding special technology and systems for rural transportation of the disabled have been given less attention than have those posed with similar orientation in urban and interurban contexts. Yet transportation problems exist in rural areas for all citizens, not just the disabled. On the one hand, travel within a given small community is restricted because fixed-route bus systems are likely to be either absent or inadequate, thus forcing individuals to depend on either taxis or personal cars. A partial solution here may lie in the taxi-bus concept, which was implemented in the Battlefords, Saskatchewan (33). The taxis provide local transit service, with provision for the disabled, and act as feeders to a mainline lift-equipped, fixed-route bus that connects North Battleford and the town of Battleford. Evaluation of this system suggests that the concept would be feasible in communities of about 20,000 people, together with or instead of a fixed-route bus system. The GSM taxi mentioned earlier would be a suitable form of technology for this type of system.

An intracommunity transportation alternative for the disabled is the mobility club concept. Mobility clubs enlist the services of volunteer drivers with access to private cars and, through centralized coordination, match driver trips with potential users. An exploratory attempt was initiated in Huron County, Ontario, in 1978 to create and test rural application of this concept (34). During the 17-month period, attempts to create a centralized mobility club failed. However, about five individual mobility clubs related to specific, local activities were spontaneously organized by small groups. The lesson learnt is that the rural development process is a slow one. Schedules and deadlines such as those imposed by demonstration projects cannot be effectively executed by an external agent. The concept does not lend itself to the setting up of a centralized dispatching agency, but has to be activity- or group-specific. The project did provide an excellent opportunity to draw conclusions on the nature of the transportation problems in rural areas, and the potential of volunteer driver systems for meeting transportation requirements.

Options for travel outside small Canadian communities have been reduced because, for economic reasons, VIA Rail has withdrawn its services from such areas (35), thus leaving residents wholly dependent on buses. Although an appropriate lift represents a solution for wheelchair passengers in those cases where both origin and destination have terminals, such is not the case when the town or village bus stop is merely some point on the highway. This difficulty appears to be beyond the range of means available to the transportation technologist and, instead, within the realm of social applications.

Conclusion

On balance, then, Canada has taken many creative approaches to the multi-faceted issue of how the rights of its disabled citizens to full transportation service can be satisfied through changes in technology and systems. As a consequence, numerous innovative devices and concepts have been developed and implemented within urban, interurban, rural and small city systems throughout the country. Moreover, the Special Parliamentary Committee's 1981 recommendations have produced an upsurge in relevant research and development.

Complementing innovative technology and systems development is the recognition that better services for the disabled must involve attitudinal and procedural changes. To this end, Transport Canada published a resource handbook

that instructs transportation personnel in recognizing, understanding and assisting travellers with special needs (36). Air Canada and VIA Rail, also recognizing the need to ensure sensitive and effective service, provide audio-visual and practical training courses for their passenger service personnel.

In addition, TDC has prepared a national transportation guide to inform travellers with special needs of services available to them (37). The guide describes facilities, policies and procedures of the railway, airlines, ferry operators and bus companies. Also included are the floor plans of major terminals. To date, ten thousand copies of the guide have been distributed to disabled travellers and to providers of transportation services.

While taking pride in these endeavours and achievements, Canada remains very much aware of the extent of work to be done before disabled persons here can enjoy all the advantages that transportation technology can afford them.

References

1. Special Committee on the Disabled and the Handicapped. Obstacles. Canada, House of Commons, Ottawa: February 1981.

2. Urban Transit Authority of British Columbia. Victoria lift-equipped bus demonstration programme: Final report. Victoria: October 1980.

3. Labelle, C. (Commission de transport de la communauté urbaine de Montréal). Personal communication, July 1982.

4. Technical Advisory Committee on Improved Accessibility. Report on improved transit accessibility for handicapped and elderly. Toronto Transit Commission, Toronto: December 1980.

5. Underhill, F. (Calgary Transit System). Personal communication, July 1982.

6. Strachan, G. (Edmonton Public Transit). Personal communication, July 1982.

7. Adam, R.B.L. (B.C. Transit). Personal communication, July 1982.

8. Watson, R. (Flyer Industries Ltd.). Personal communication, August 1982.

9. Canadian Rehabilitation Council for the Disabled. Information directory on urban transportation services for physically disabled persons in Canada. Toronto: December 1981.

10. Kaulback, P.J. and Eryou, N.D. Paratransit vehicle technology: Guidelines for regulators, operators, and vehicle developers. DeLeuw Cather Canada Ltd., Ottawa: May 1982. TP 3648E.

11. Peat, Marwick & Partners, Ltd. Urban transportation for the disabled. (Report prepared for the Ontario Ministry of Transportation and Communications). Toronto: January 1975.

12. Forest, J. and Versailles, C.A. Evaluation of a subcompact station wagon modified to transport the handicapped. Transportation Development Centre, Montreal: August 1979. TP 1777

13. Gravel, M. Transit vehicle for the disabled: Phase 1 - Definition of requirements. DeLeuw Cather Canada Ltd., Ottawa: February 1982. TP 3523E.

14. Guillon, Smith, Marquart & Associés Ltée. Innovative paratransit vehicle: The GSM taxi. Montreal: July 1980. TP 2688

15. Smith, B.A. and Nishizaki, R.S. Compendium of transportation equipment for disabled persons. Transportation Development Centre, Montreal: June 1981. TP 3618E.

16. Rutenberg, U. Multimodal wheelchair securement/ passenger restraint: Prototype development. Les Designers Douglas Ball Inc., Ste Anne de Bellevue, Quebec: May 1981. TP 3057E.

17. Ontario Ministry of Transportation and Communications. New regulations affecting vehicles for the transportation of physically disabled passengers. Ontario Ministry of Transportation and Communications, Toronto: April 15, 1981.

18. Ball Berezowsky Associates. The design and development of a curb-climbing electric wheelchair. Ste Anne de Bellevue, Quebec: June 1978. TP 1500.

19. Nicklin, J. Quick release hand controls for automobiles: Prototype design and evaluation. Davis Engineering Ltd., Ottawa: June 1982. TP 3779E.

20. The Elswick Envoy: More mobility for the disabled driver. (Advertisement brochure). Elswick Special Vehicles Ltd., Alcester, Warwickshire, England: 1980.

21. "Nordair et les aveugles: Innovation". Journal de Montréal, Montreal: June 16, 1980.

22. Rutenberg, U. and Barber, M. Travellers with special needs: Facility design compendium (illustrated). Les Designers Douglas Ball Inc., Ste Anne de Bellevue, Quebec: 1982. TP 3608E.

23. Rutenberg, U. and Barber, M. Travellers with special needs: Modular transfer platform design concept. Les Designers Douglas Ball Inc., Ste Anne de Bellevue, Quebec: 1982. TP 3796E.

24. VIA Rail Technology Department. VIA station standards specifications for special needs. VIA Rail Canada, Montreal: June 1981.

25. Noble, C. "What year of the disabled has meant to those who would like to travel". Toronto Star, Toronto: January 30, 1982.

26. Air Canada. Air travel for disabled persons. 1982.

27. Nicklin, J. Protective container for wheelchairs: Prototype build. Davis Engineering Ltd., Ottawa: January 1982. TP 3491E.

28. McCaffrey, W.F. Air transport of wheelchair batteries. TES Ltd., Ottawa: September 1981. TP 3210E.

29. VIA Rail Canada. VIA Rail's five-year program for passengers with special needs. Montreal: 1981.

30. Rutenberg, U. Wheelchair tie-down/passenger seat prototype development. Douglas Ball Inc., Ste Anne de Bellevue, Quebec: November 1978. TP 1821.

31. Van Humbeck, T. and Woods, D.K. Wheelchair access system for intercity buses. TES Ltd., Ottawa: September 1981. TP 3186E.

32. Magee, J., Jones, D.H. and Walter, J.F. Decision in the matter of the inquiry respecting intercity bus service to the disabled in Newfoundland. Canadian Transport Commission, Ottawa: December 1981.

33. N.D. Lea & Associates Ltd. & Stanley Associates Engineering Ltd. Shared ride taxi implementation and evaluation study. The Battlefords, Saskatchewan. Saskatchewan: 1981. TP 2879.

34. Hickling-Smith Inc. The mobility club concept in rural areas: A demonstration project in Huron County. Transport Canada, Urban Transportation Research Branch, Montreal: September 1980. TP 2646.

35. "Nouvelles coupures possibles à VIA Rail". La Presse, Montreal: October 30, 198 .

36. Hickling-Partners Inc. A guide to recognizing, understanding and assisting travellers with disabilities. Transport Canada, Ottawa: 1981. TP 3461.

37. Transportation Development Centre. Transportation in Canada: A guide for travellers with special needs. Montreal: 1981. TP 380.

Centre de développement
des transports
1000 o., rue Sherbrooke
Suite 2421
Montréal, Québec
H3A 2R3

Transportation
Development Centre
1000 Sherbrooke St. W.
Suite 2421
Montreal, Quebec
H3A 2R3

POOR

QUALITY

ORIGINAL